Citizen Science in Glacier's High Country: Mountain Goats, Pikas and Clark's Nutcrackers

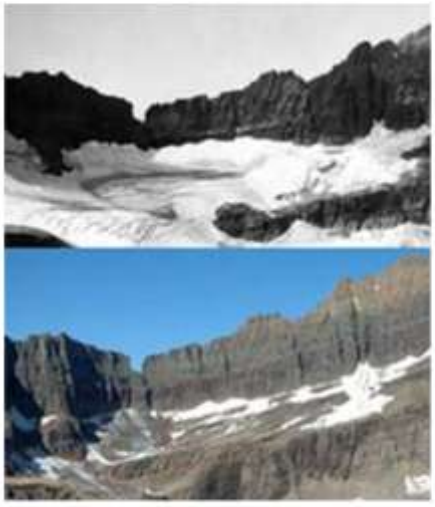
Many changes are happening in Glacier's alpine and subalpine areas, causing growing concern about many high country plants and animals. These changes include invasions of insects and plant diseases, climate change, and a growing number of recreationists. Some individual species like whitebark pine (current estimates are of 50-60% mortality in most stands) are clearly in trouble and others, such as the Clark's Nutcracker (a species that has coevolved with whitebark pine), seem to be declining. But, in general, we don't know how healthy most of the animal and plant populations currently are in Glacier's alpine and subalpine areas nor how resistant they are to change. We need to know more in order to maintain and restore the health of this ecosystem.

The Citizen Science in Glacier's High Country project will engage volunteers to help determine the number and distribution of three of the wildlife species that we are currently most concerned about: mountain goats, Clark's Nutcrackers, and pikas. The status each of these species in Glacier is unknown.

Volunteers will receive training on species identification and will be taught how

to observe and what to note about each species. Volunteers will also learn about the current state of knowledge about the distribution of each species in Glacier, the life history of each species, and the management concerns for these species in the park.

Why are we concerned about mountain goats, pikas and Clark's Nutcrackers?



What we don't know could fill a book

- How healthy are Glacier's alpine and subalpine animal and plant populations?
- How resistant are they to change?

Climate change

- Global average temperature has increased 1.5°F over last 100 years
- Earth's surface predicted to warm as much as 10 degrees by 2100
- Alpine and subalpine animals and plants cannot seek higher ground

Proliferation of plant diseases and insects

- Warmer winter temperatures have exacerbated effects of blister rust and mountain pine beetle on whitebark pine- a high country keystone species

Why are we concerned about mountain goats?

Mountain goats have been monitored at a few isolated locations in Glacier National Park, such as the Walton Goat Lick, where the goat numbers have declined in recent years. However, little research has been conducted on overall population and where mountain goats are found and throughout the Park. Such baseline information is critical for making informed management decisions and for determining how mountain goat populations may respond to the effects of global climate change.

Climate change and glacial recession are both prominent factors affecting the land use and natural resources within and around Glacier National Park. Little is known about how Glacier's mammals in general and mountain goats in particular will respond. Specifically, despite some habitats that are literally melting away, others may be created. Potential effects on goat survival, reproduction, food limitation, and distribution remain highly uncertain.


Mountain Goat Monitoring Objectives:
•Enlist help of GNP staff and visitors to get much-needed baseline information about a species that may be impacted by climate change
•Map park-wide distribution of mountain goats
•Monitor population trends of mountain goats
•Conduct annual "Mountain Goat Days" population count (August 21- 22)

Ecology:

Female-juvenile (nursery) groups range in size from 2 to over a dozen mountain goats in native populations.

Large groups generally occur during early summer congregation on prime feeding grounds or on mineral licks.

Social structure is maintained by a dominance hierarchy

As the summer progresses and the vegetation dries out, group size diminishes. Although juveniles are normally found in the company of adult females, a goat of any age or sex may be alone

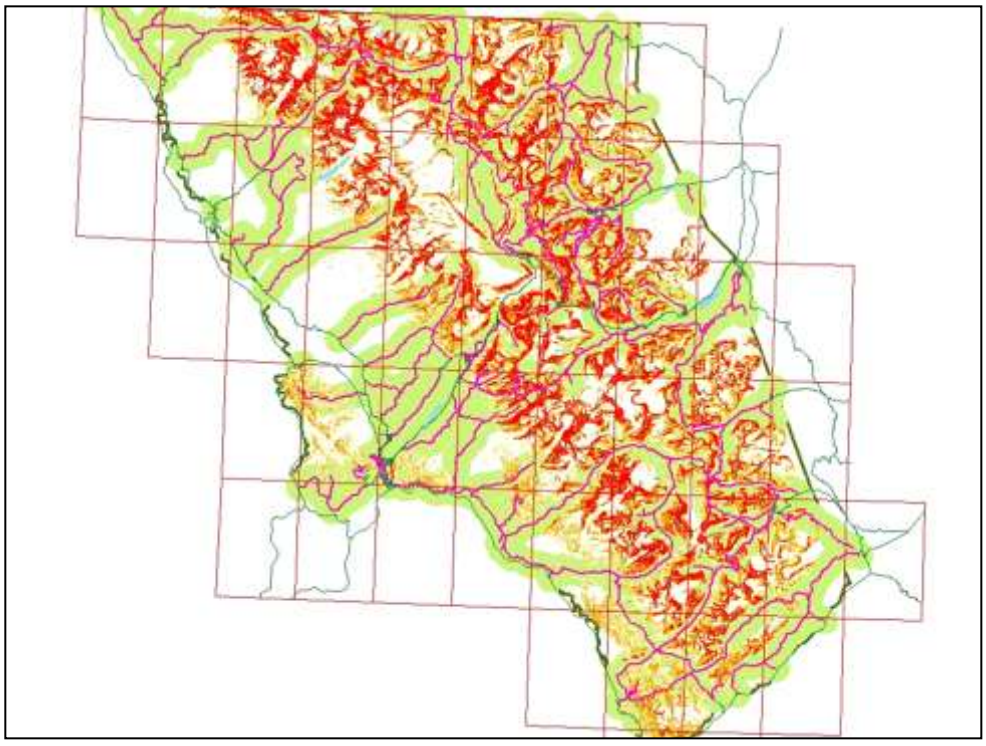
By the age of 2, males begin to disassociate themselves from nursery groups. Adult males generally lead solitary existences, associating primarily with other males except for during the mid November through early December mating season.

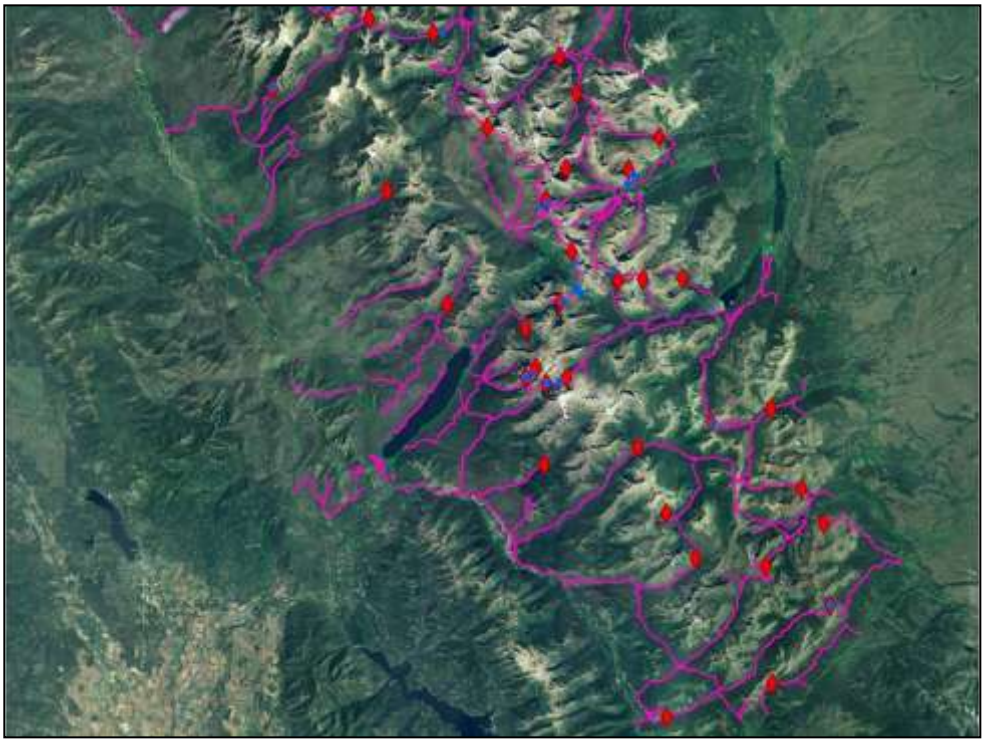
Behavior:

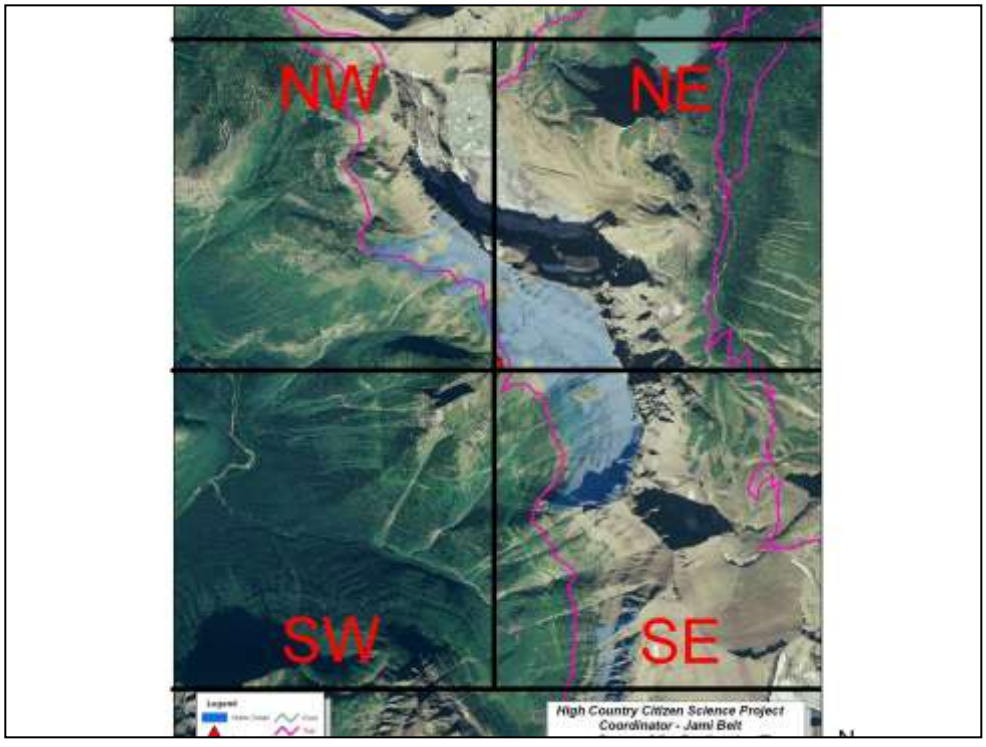
Reproduction:

Neighbors:

Mountain Goat Habitat:



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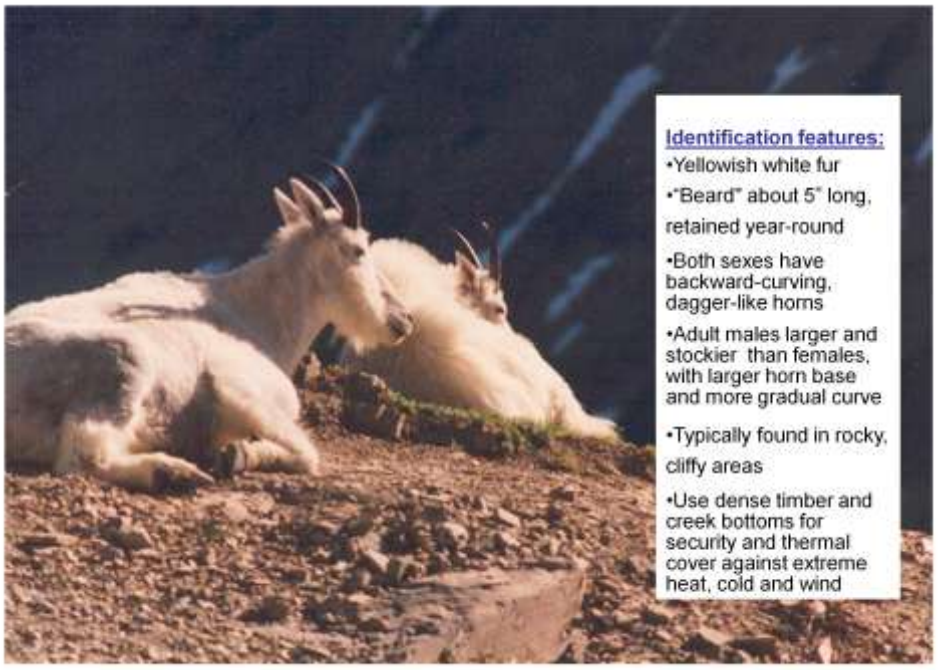
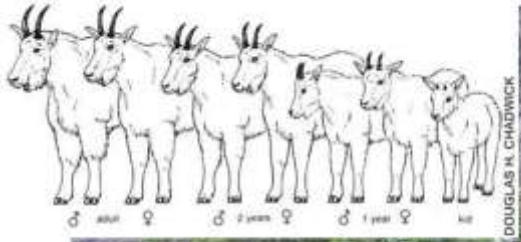
High Country Citizen Science Project
Coordinator - Jami Belt

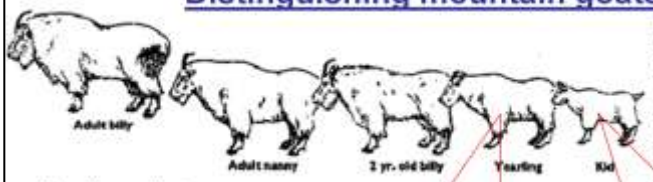

Identification features:
•Yellowish white fur
•"Beard" about 5" long, retained year-round
•Both sexes have backward-curving, dagger-like horns
•Adult males larger and stockier than females, with larger horn base and more gradual curve
•Typically found in rocky, cliffy areas
•Use dense timber and creek bottoms for security and thermal cover against extreme heat, cold and wind

Distinguishing mountain goats by age



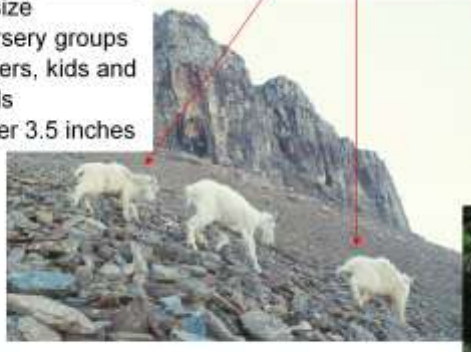
DOUGLAS H. CHADWICK

Distinguishing mountain goats by age



Kids (young of year)
- born late May/ early June
- ¼ adult size
- closely follow their mothers
- horns barely visible- less than 3.5 inches long

Yearlings (between one and two years old)
- ½ adult size
- Form nursery groups with mothers, kids and 2 year olds
- horns over 3.5 inches



Adults

Once mountain goats are two years or older they are hard to discern from other adults. Mountain goats continue to grow through their fourth year.

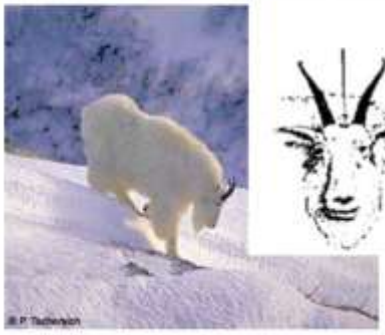
Distinguishing mountain goats by sex

Billy

Adult Billy

- Larger horn base
- Horn base wider than eye width
- Gradual curve

Yellow Stained Rump Patch

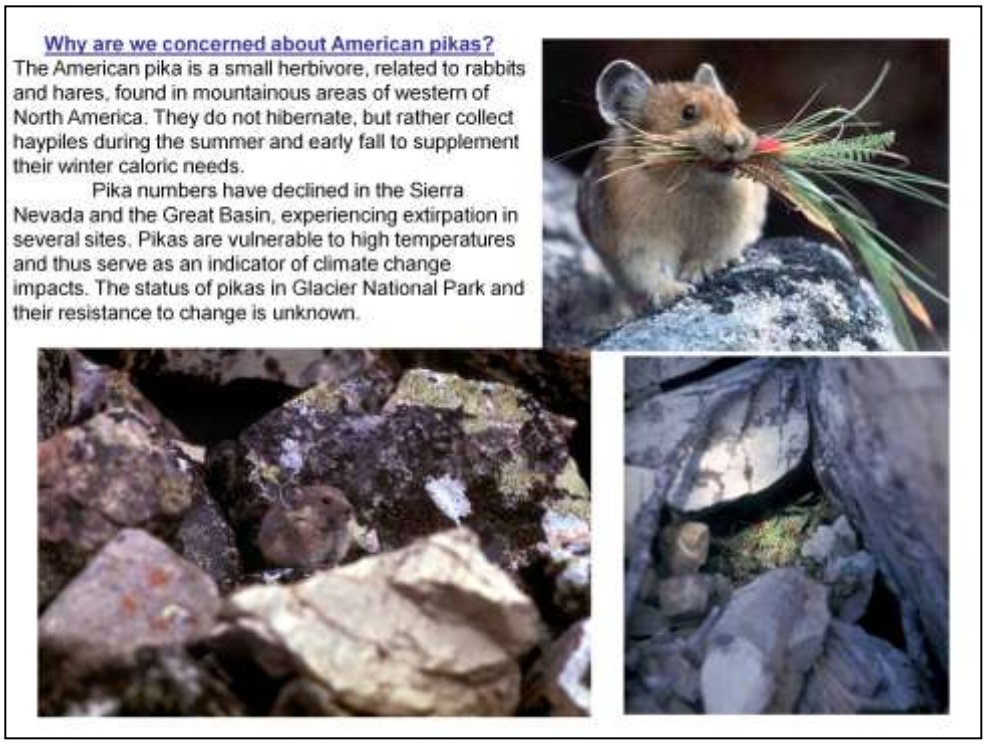


Adult Nanny

- Smaller horn base
- Sharp horn curve
- Wide space between horns

Nanny


Verification photos are extremely helpful



American pikas "put a face" on the consequences of climate change for montane biota, serving as a likely early-warning indicator, due to their low vagility, low reproductive capacity, high energetic requirements, obligate relationship to talus habitat, and demonstrated vulnerability to high temperatures.

Focal organism. The American pika (*Ochotona princeps* Richardson) is a medium-sized (150 g) diurnal lagomorph that lives up to 7 years and is found in mountainous areas of western of North America, from British Columbia to California and New Mexico (Smith and Weston 1990). American pikas are specific to talus or piles of rocks 0.2 – 1.0 m in diameter and fringed by vegetation, with a preference for the largest rocks (Brown et al. 1989; Tyser 1980). *O. princeps* defend individual home ranges of ~400 m2 and larger habitat patches have a higher probability of persistent occurrence (Smith and Weston 1990). They do not hibernate, but rather collect haypiles during the summer and early fall to supplement their winter caloric needs. The combination of sightings, identifiable calls, and the presence of fresh haypiles or feces, makes them among the easiest mammals to detect in a single visit (Beever et al. 2003, Beever et al. *in review*, C. Ray and E. Beever *unpubl. data*). The above factors greatly minimize the likelihood of overlooking pika presence (false negatives), especially when sampling during periods of greatest activity.

There are numerous lines of evidence suggesting pika range distribution is affected by temperature. At its highest latitudes, *O. princeps* is found at elevations ranging from 3000 m to sea level. The lower elevational limits of its range become progressively higher with decreasing latitude, as found by Grinnell (1917). At its southern limit, it is uncommon to find pikas lower than at 2500 m (Smith and Weston 1990). Pika basal metabolic rate is high (143% of predicted weight-specific value) and thermal conductance is low (101-53% of predicted values; MacArthur and Wang 1973). As a result, their body temperature is high (mean = 40.1°C) and upper lethal temperature is relatively low (mean = 43.1°C; Smith 1974). Hyperthermia and death may occur at moderate (25.5-29.4°C) ambient temperatures (MacArthur and Wang 1973; Smith 1974). Kreuzer and Huntly (2003) found that earlier spring snow melt is positively correlated with population growth rate. Applying species-area relationships and tenets of island biogeographic theory, McDonald and Brown (1992) predicted pikas were the 4th (out of 13 modeled mammal species) most vulnerable to local extinction in Great Basin mountain ranges, given a scenario of a 3°C temperature increase.

Species range modeling. Thus far, efforts to identify broad principles that govern spatial and temporal distributions of mammalian populations have been largely unsuccessful. One apparent reason is that species utilize landscapes and respond to environmental change in different ways. For example, many extant mammals, whose ranges overlapped during the last glacial maximum (LGM), are no longer sympatric (Graham, 1986). On broad time scales, species-specific responses to climate change drive extinction and speciation events, while on shorter time scales they influence community composition and distributions. Species range shifts under climate warming scenarios in western North America of 2-5 °C over the next century (Cubasch et al. 2001) will likely have complex distributional consequences on the relationship between range size, latitude, and elevation (Brown et al. 1996). High latitude montane systems are excellent arenas for examination of these shifts because they will likely serve as climatic refugia for cool-adapted montane mammal species (Guralnick 2007). In order to increase our ability to accurately predict range shifts in response to climate change, it is important to consider each species' response individually, with a focus on the biophysical mechanisms that limit their range in addition to correlative associations which will likely change over time. Mechanistic models are also needed given the likelihood that some future climates will lack current analogs (Williams et al. 2007). Additionally, there is a need to cross-check the species-

range predictions made by regression and biophysical models.

Most models of mammal distribution are based on qualitative descriptions and evaluated empirically based on goodness of statistical fit, such as regression analysis. They are limited, however, in that their power is severely reduced when they are used to predict range expansions and shifts over long periods of time, due to extrapolation beyond the modern data set (Williams et al. 2007). In addition, correlative models are less useful for assessing mechanistic hypotheses. For example, Burns et al. (2003) conducted a study that predicted mammal species turnover in eight U.S. national parks as a function of expected vegetation shifts, in a 2.5˚C climate-warming scenario. Their analysis predicted a substantial shift in mammal-species compositions. Although their work was a useful condensation of empirical facts using statistical regression, their predictions were based upon the assumption that mammals would relocate in concert with vegetation. Burns et al. (2003) concluded that scientists need to develop models that mechanistically account for the effects of climate change and mosaic habitats. As such, development of models that utilize species-specific physiological properties, in conjunction with local climate information, is crucial to achieve applicability to real-world ecological situations such as protected-areas management (Mackey and Lindenmayer 2001). Furthermore, mechanistic models can be utilized on a broader suite of species (Porter et al. 2000). Here, models that use biophysical first principles to mechanistically predict distribution will be called "biophysical" models, whereas correlative empirical models will be called "regression" models. Additionally, when comparing biophysical and regression models, it is important to distinguish between the ecological significance of their respective predictions.

Fundamental vs. Realized Niche. There is a basic distinction between the space that an organism could inhabit and the space that it does inhabit. The **fundamental niche** is primarily a function of physiological performance and ecosystem constraints; whereas, the **realized niche** includes these constraints as well as biotic interactions and anthropogenic influences. Biophysical models can parameterize the fundamental niche, and later include competitive principles to predict the final response. Regression models, on the other hand, predict only the realized niche. For this reason, regression models are severely limited in application when environmental conditions are changing (Guisan and Theurillat, 2000). Additionally, there can be significant differences in predictions of distributional changes using regression versus biophysical modeling (Kearney and Porter 2004)

Niche Mapper. To date, very few successful models have been developed to describe mammal distributions based on biophysical properties, due to demands on information (e.g. physiology, morphology, behavior, landscape, microclimate) and technical ability (e.g. engineering, computer programming). Since 1969, Dr. Warren Porter has been developing and improving a first-principles model which has been used successfully for both endotherms and ectotherms (Porter and Gates 1969; Porter 1988; Porter et al. 1994; Porter et al. 2002). This year, Dr. Porter's model was patented under the name "Niche Mapper". Niche Mapper calculates the fundamental niche of an animal using the physiological, allometric, and life-history characteristics (Figure 2). Mass, heat, and water-balance equations can be derived for any animal from the metabolic rate, surface properties, and basic environmental properties (e.g. air temperature, relative humidity). This method has been shown to have both high accuracy and broad taxonomic applicability (e.g., Porter et al. 2000). Recently, it has been used successfully to predict food and water requirements and distribution limits of reptiles in Australia (Kearney and Porter 2004), the Po'ouli on Maui (Porter et al. 2006), and the endangered serow deer on Honshu, Japan (Natori and Porter 2007).

Geographic Range

American pikas, Ochotona princeps, are found in mountain habitats from central British Columbia to South-Central California and east to Colorado.

Biogeographic Regions:

nearctic (native).

Habitat

American pikas are found in areas of broken rock and talus, which are surrounded by suitable vegetation. They are most often found at the interface between meadow habitat and open rocky terrain.

Terrestrial Biomes:

taiga ; mountains .

Physical Description

Mass

100 g (average)

(3.52 oz)

[External Source: AnAge]

Length

162 to 216 mm

(6.38 to 8.5 in)

Basal Metabolic Rate

Ochotona princeps is a moderate sized pika with buffy underparts (as opposed to white in Ochotono collaris). As in other pikas, the ears are short, the tail is not readily visible, and the body is egg-shaped. Measurements: Body length: 162 to 216 mm; Hind foot: 25 to 35 mm.

Some key physical features:
endothermic ; bilateral symmetry .

Reproduction
Breeding interval
These pikas breed two times per year.

Breeding season
These animals breed before snow melt, and again after the birth of the first litter.

Number of offspring
1 to 6; avg. 3

Gestation period
30 days (average)

Birth Mass
9 g (average)
(0.32 oz)
[External Source: AnAge]

Time to weaning
18 to 35 days

Time to independence
4 weeks (average)

Age at sexual or reproductive maturity (female)
347 days (average)
[External Source: AnAge]

Adult females have two litters per year and have a postpartum estrous. First litters are usually conceived about one month before snowmelt so that lactating females can feed on the spring emergence of alpine grass. There is a much lower rate of weaning second litters than first litters (less than 10% of weaned juveniles are second litter), apparently due to the high energetic cost to the female of weaning.

Average litter size ranges from 2.3 to 3.7. Young are completely dependent on their mother for at least 18 days, but exhibit a remarkable rate of growth and reach adult size after only 3 months.

Weaning generally occurs at 3 to 4 weeks after birth, and after 4 weeks, siblings are intolerant of each other and of their mother.

Key reproductive features:
iteroparous ; seasonal breeding ; gonochoric/gonochoristic/dioecious (sexes separate); sexual ; viviparous ; post-partum estrous.

Behavior
American pikas are active outside their dens about 30% of daylight hours. Much of this time is devoted to feeding, haying, surveilance and territory defense. Adults establish and defend independent territories and territories of males

tend to be adjacent to females. Pikas use two characteristic vocalizations, the short call and the song. The short call is given as an alarm call to alert others of avain predators and as a territory defense call. The song is given primarily by males during the breeding season, but both males and females may sing during the autumn.

Key behaviors:

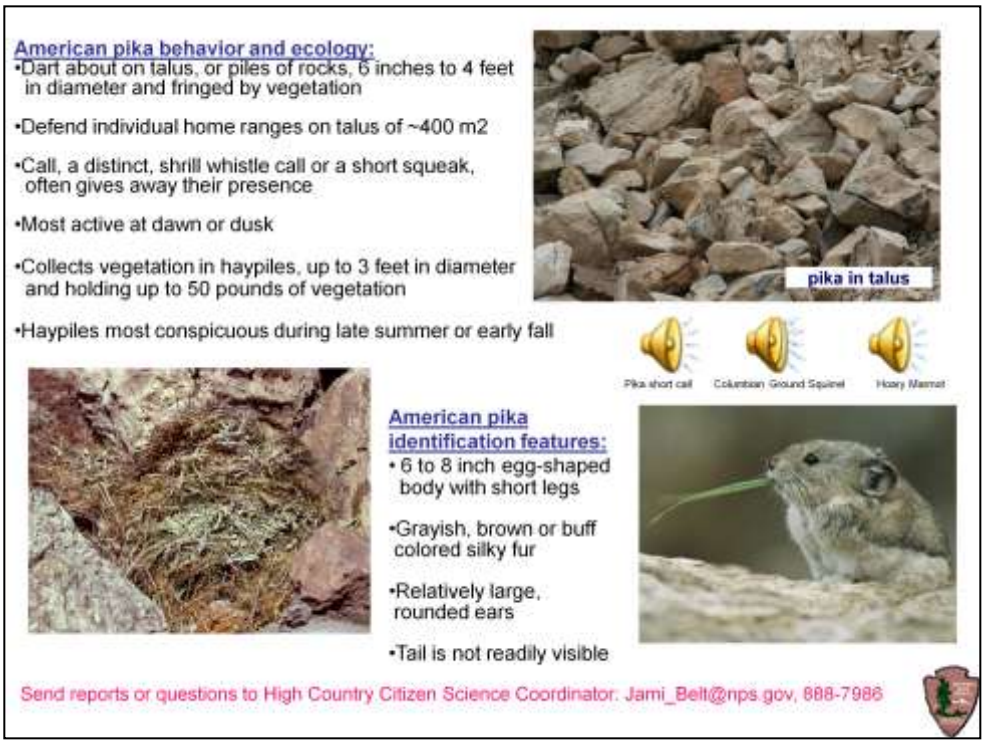
motile ; social .

Food Habits

Pikas utilize two distinct foraging styles: open foraging (feeding) and food collection and caching (haying). During the summer, they cache vegetation in haypiles. Haypiles are composed of tall grasses and forbes and may be cached on open surfaces or under rocks. These haypiles are used to supplement their diet during especially harsh winters. Pikas collect as much vegetation as possible during the haying season, but haypiles are insufficient to sustain them through the winter. Pikas must therefore continue to feed during the winter. Pikas generally feed on short alpine grasses during the summer and on cushion plants and lichens that are accessed by underground tunnels during the winter.

Primary Diet:


American Pika Monitoring Objectives:
•Enlist help of GNP staff and visitors to get much-needed baseline information about a species that may be impacted by climate change
•Develop sampling protocols for long-term monitoring of pikas
•Document new locations of pikas and talus habitat for future monitoring
•Conduct surveys at known talus habitat sites to help assess detectabilty of pikas in conjunction with L. Moyer-Horner 's (U of Wisconsin) study of climate change response in pika populations



Young are born May-September (possibly March in some low elevation areas). Female produces 1-2 litters of 2-5 young/litter. Young depend on mother for at least 18 days, and are weaned at 3-4 wk. Juveniles establish territories and haypiles, but do not breed until second summer.

In the winter it lives under the snow in tunnels, feeding off piles of hay it has stored inside.

A study reported in the US Journal of Mammalogy found that in pika populations at 25 places nearly 30% of the animals had gone. The locations are so remote that there seemed to be no other factor than climate change.

Pikas are sentinels of change in other montane species

- Specific to discontinuous talus habitat
- Relatively poor dispersers
- Vulnerable to high temperatures
  - High body temp (104°F), high metabolic rate
  - Low upper lethal temp. (109°F)
  - Excellent insulation
  - Death can occur at ambient temperatures above 78°F

Ecology

- Generalist herbivores
  - Central place foragers
  - Haying vs. direct feeding
  - Coprophagy
- Individually territorial
  - Home range = 18 – 25m radius
  - Territory = 11 – 15m radius

Reproduction

- 2 litters/yr., 30-day gestation
- Among fastest growing lagomorphs (relative of rabbits)
- Wean as early as 4 weeks
- Annual mortality = 37– 46%
- Max. 7-year lifespan

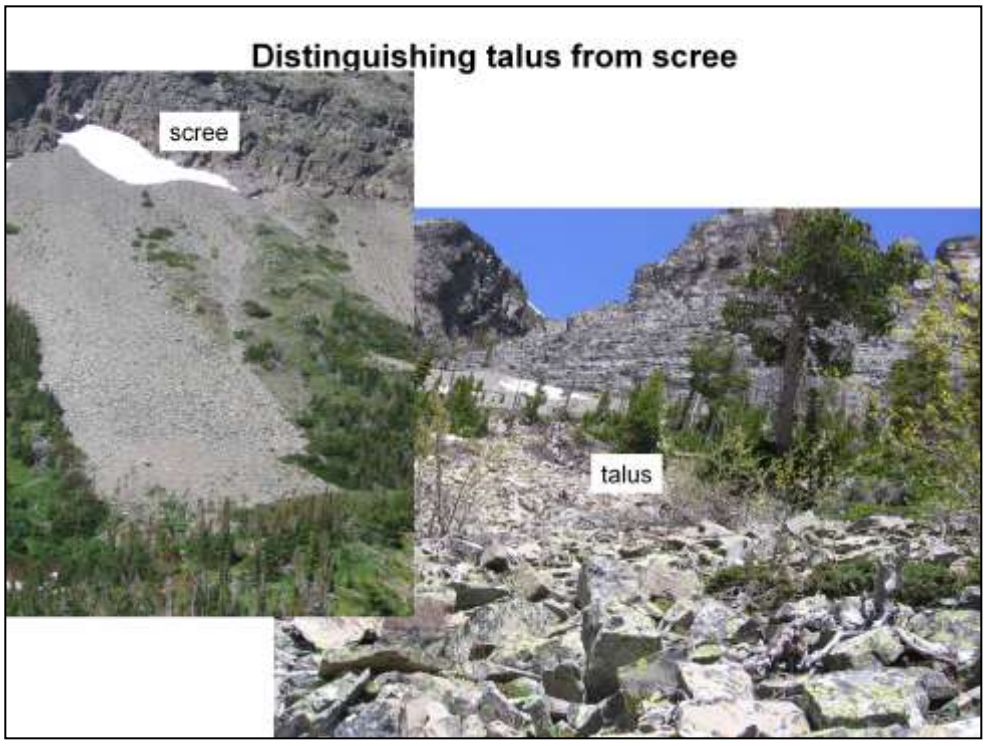
Behavior

- 25% of juveniles disperse
- Young usually remain in natal area
- Active 30% of daylight hours
  - Surveillance, haying/feeding, vocalizing, and territory establishment and maintenance

Habitat

- Specific to talus (piles of boulders >1 ft. diameter)

Identifying talus sites to map potential pika habitat

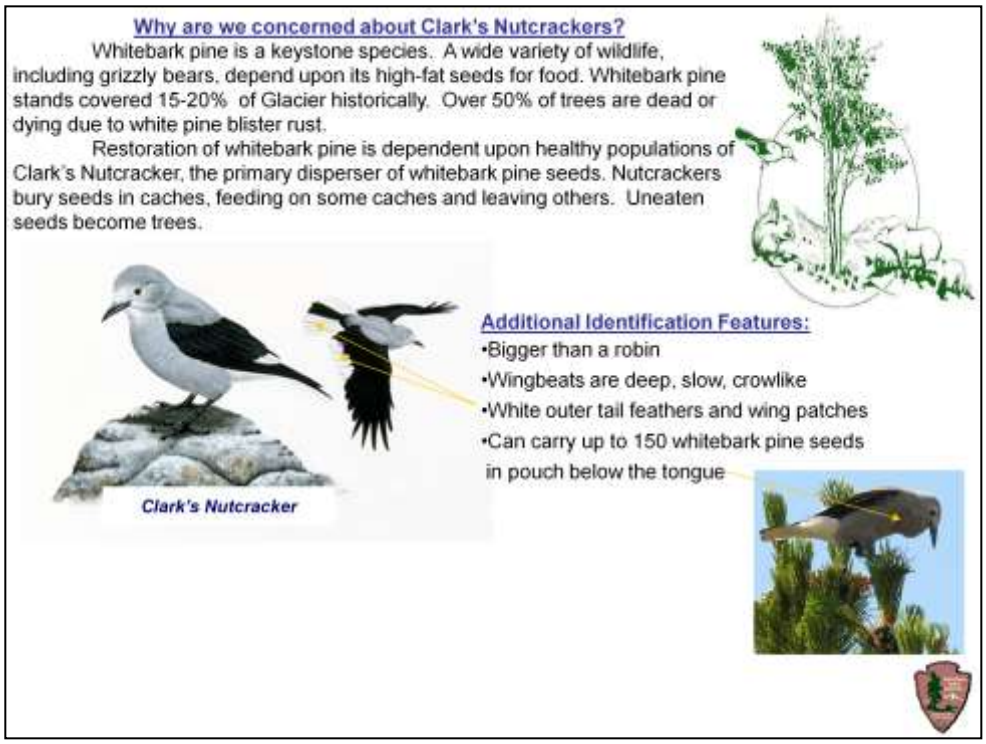

Distinguishing talus from scree
scree
talus

Identifying pika sign

Take verification photos of all haypiles and collect scat samples from each haypile

Neighbors

- Often live near marmots, chipmunks, ground squirrels, and bushy-tailed woodrats
- Primary predators include coyotes, longtail weasel, shorttail weasel, and pine martens



The number of nutcrackers in and around Glacier are very low, based on several different data sources from in and around Glacier (from a doctoral student studying nutcrackers in whitebark pine stands in Glacier; the songbird point counts funded by GNPF and conducted parkwide in 2005 and 2006; the US Forest Service Northern Region Landbird Monitoring Program).

Clark's Nutcracker Monitoring Objectives:

Enlist help of GNP staff and visitors to get much-needed baseline information about a species that may be impacted by climate change and loss of a major food source (whitebark pine)

Develop sampling protocols for long-term monitoring of Clark's Nutcrackers

Document locations of all Clark's Nutcracker sightings for future monitoring

Document locations of breeding pairs or family groups and nest sites to assist with T. Lorenz's (Utah State U.) 2009 radio telemetry study to determine habitat type required by CLNU in GNP

Do not confuse the Gray Jay with the Clark's Nutcracker.

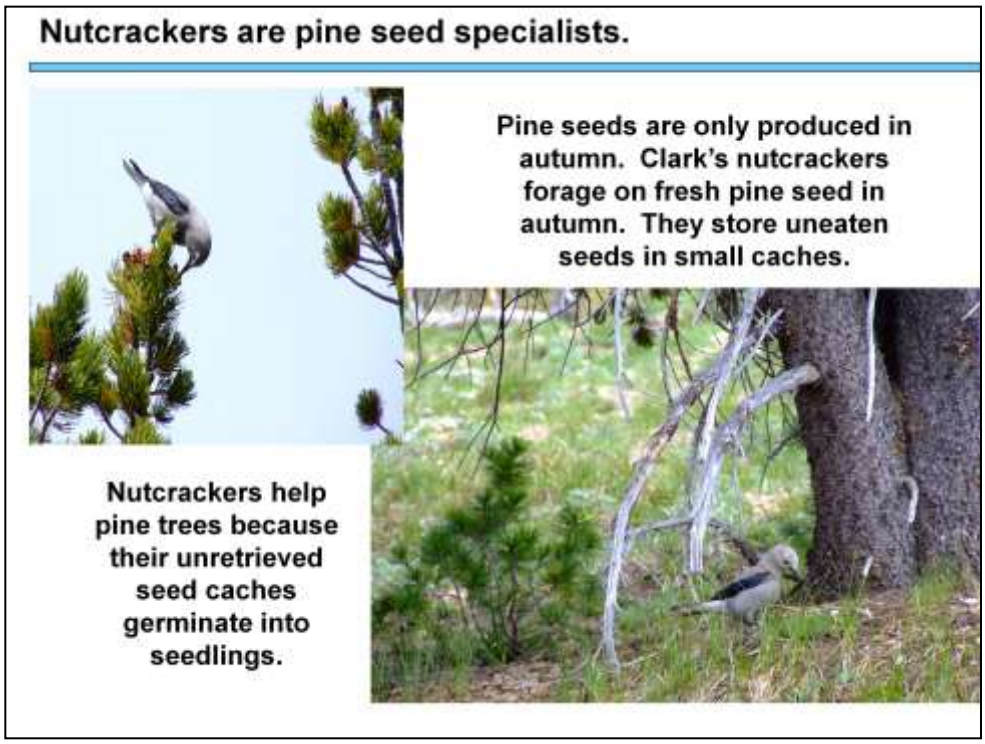
Clark's Nutcracker:

- Chunky light to medium gray bird with black wings and tail; white outer tail feathers and wing patches
- Bill is black, long and thin
- Call is a nasal, grating, drawn-out "kra-a-a"; audible at great distances

Gray Jay:

- Overall dark gray appearance; no bold white or black markings on wings or tail
- Small bill
- Call notes include a whistled "wheeoo" and a low "chuck"

Send reports or questions to High Country Citizen Science Coordinator: Jami_Bell@nps.gov, 888-7986



•For what reason would birds have evolved such an incredible brain?

•Nutcrackers are pine seed specialists; for millions of years they have foraged on pine seed.

•But pine seed is produced only in autumn; so nutcrackers stored huge quantities of seeds in autumn

•They store seeds in lots of locations, in the ground and in trees depending on the nature of the area where they live

•Nutcrackers have some unique morphological adaptations: they have a pouch below the tongue that is like a non-digesting stomach: they transport seeds in this pouch between harvest trees, and cache sites where they place seeds.

•These seed caches can be smelled below the ground by mammals; nutcrackers therefore scatter their caches over a 600 ha area (rather than putting all of their eggs in one basket)

•Nutcrackers rapidly harvest seeds from trees every autumn: in exchange for a year-round high energy food source, nutcrackers do trees a service: they plant seeds! Nutcrackers forget many caches or don't retrieve them for other reasons and these caches can grow into mature trees

Nutcrackers rely on stored pine seed in winter for survival and in spring for raising their young.

Clark's nutcracker and whitebark pine are coevolved mutualists

Whitebark pine and Clark's nutcracker have evolved together for millions of years.

True mutualisms in megafauna are rare

•While nutcrackers forage on many species of pine seed, they have a unique relationship with one tree, whitebark pine

•A relationship this close and mutualistic is rare in megafauna

•Whitebark pine requires nutcrackers to disperse its seeds: it has evolved special cones and the seeds are only released when nutcrackers break into them

•Whitebark pine seeds are very large and therefore in most instances, nutcrackers preferentially harvest and are attracted to whitebark pine in the autumn

•Whitebark pine seeds are usually rapidly harvested from tree by nutcrackers

•Nutcrackers have evolved this life-style for millions of years and it is all because of a species of pine tree that is so closely tied to nutcrackers that it would go extinct without the nutcracker.

•The relationship between nutcrackers and whitebark pine began millions of years ago in Eurasia when the Bering Land bridge was open. Nutcrackers from Eurasia carried seeds across the bridge into North America.

Whitebark pine is a subalpine tree.

•Whitebark pine is slow growing but exceptionally hardy: it is out competed in most areas because it grows slowly but it is able to survive where no other trees can survive

•like the bird this tree is very important ecologically in its own right because it is not common but it affects ecosystems hugely because of its natural history.Whitebark pine regulates water levels and controls erosion in ourlowland areas because it moderates the spring melt off of snowpacks. It gorws in high elevations where no other tree and sometimes even plants, can grow.

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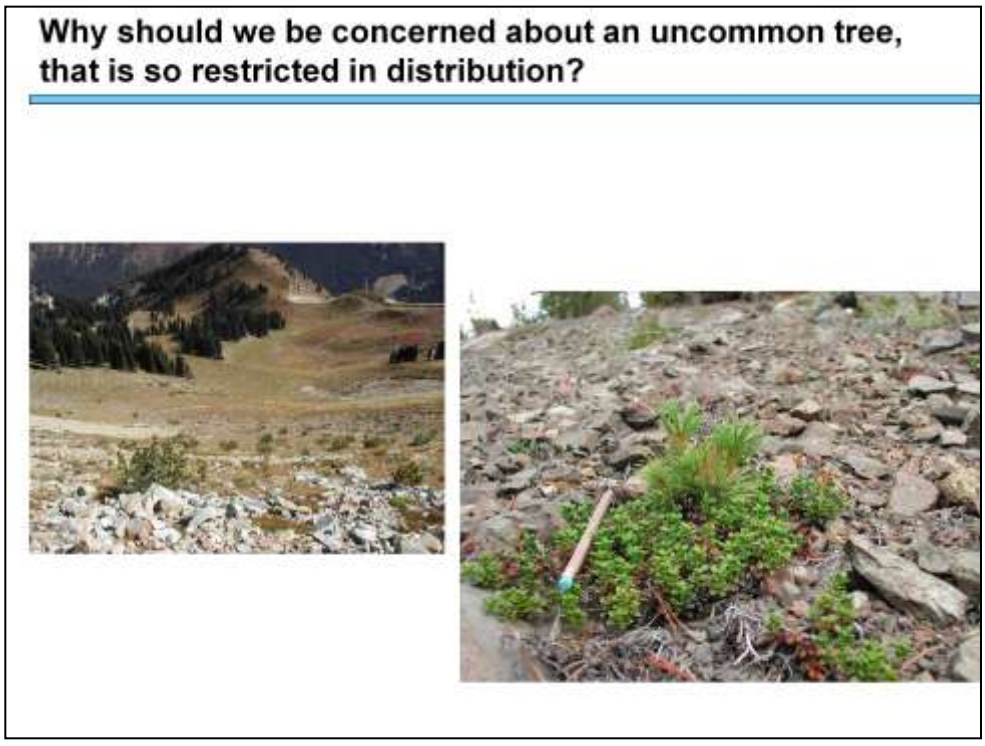


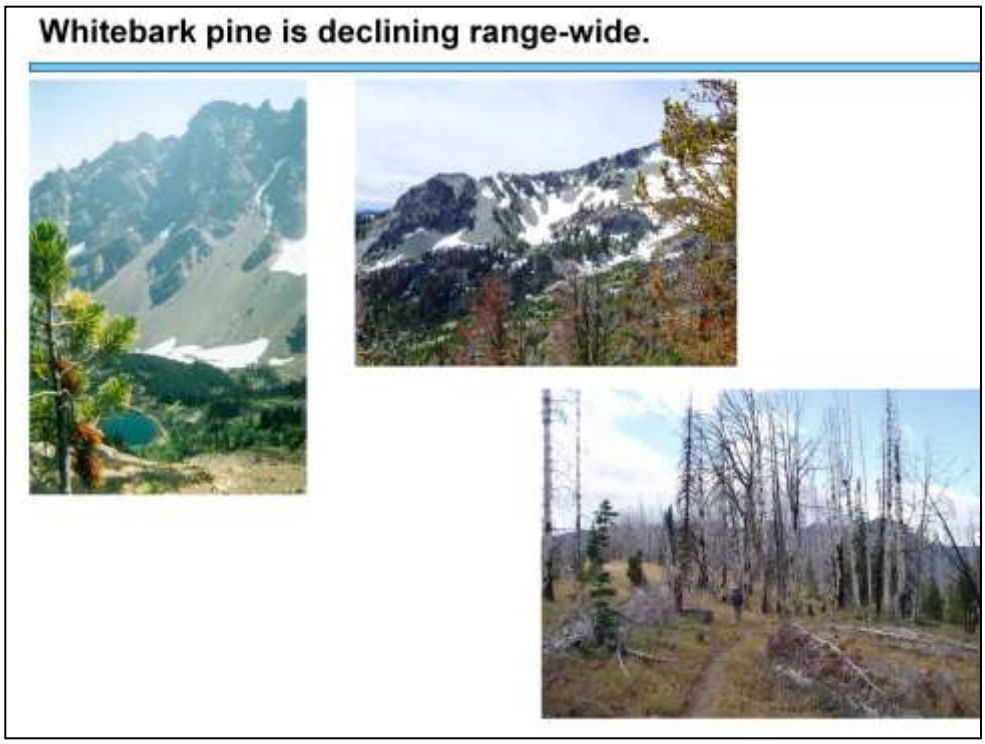
•Why should we be concerned about an uncommon tree, that is so restricted in distribution?

•Whitebark pine also has no commercial value because it grows in areas that are hard to access and does not grow straight

•Whitebark pine is considered an ecological keystone: it heavily influences ecosystem function despite having relatively low biomass in the ecosystem

Grizzly bears and Yellowstone

Yet whereever you find the tree you willfind thenutcracker because allof this depends on the bird. The tree would not grow without the bird



Unfortunately like so many things whitebark pine is declining. For about 70 years the tree slowly declined due to an exotic fungus from Europe. In the last five years global warming has led to stand-wide die-offsand has become an even bigger threat than the fungus. Because of global warming, winter average temperatures in the high elevation whiteabrk pine stands are higher than normal and not low enough to kill parasites. One parasite in particular, mountain pine beetle, has benefited from this affect and whereas it used to be restricted to warmer low elevation forests, it now is surviving over winter in whitebark pine forests. While these beetles were always present to minor degrees and killed a few trees in stands, outbreaks were not widespread and sustained for years at a time because the beetles would die back whenever there was an avearage-cold winter. With warmer winters, beetles never die back and each spring they kill new trees in stands and disperse to new nearby stands to repeat the cycle. High elevations were previously protected by cold temperatures and now they are not.

Please report the following about all Clark's Nutcracker observations on Wildlife Observation Forms (R-10):

Location and number of birds sighted

Presence of family groups (adults with young)

Type of sighting (bird flying over, perched, caching seeds or other behavior)


Project funded by
The Glacier National
Park Fund
Questions?